Delaware Sea Grant Implementation Plan

The mission of Delaware Sea Grant is to advance the understanding, development, use, and conservation of state and regional marine and coastal resources through an integrated program of excellence in research, education, and outreach built upon active partnerships with state and federal agencies, the private sector, and citizens at large. The broad objectives aimed at sustaining this mission from 2005–2010 are articulated in our strategic plan. These objectives are used to set the framework for this shorter-term, two-year implementation plan, which is designed to provide more specific guidance for Delaware Sea Grant in 2005–2007 and to set goals that are attainable during this time period (see Figure 1).

All Delaware Sea Grant activities must satisfy three major criteria:

1. *Be based on a strong rationale,*
2. *Demonstrate scientific merit as determined by national experts in the field, and*
3. *Produce application-oriented results that are clearly useful in industry, management and/or science.*

The Delaware Sea Grant core values of excellence, relevance, integrity, teamwork, and accountability inform each of these criteria.

In developing and sustaining the priorities outlined in our strategic plan, we have sought the advice of stakeholders that represent the broad community of individuals and organizations with marine interests in Delaware, the Mid-Atlantic region, and beyond (see Figure 2). Their regular and frequent input helps us sustain a dynamic and flexible view of issues through the eyes of our various coastal constituencies.

Based upon this input, the Delaware Sea Grant College Program has established five priority areas for research, education, and outreach: Ecosystems; Environmental Technologies and Engineering; Biotechnology; Marine Commerce and Transportation; and Marine Education, Literacy, and Outreach. These priority areas cross-cut a number of National Sea Grant Thematic Areas (see Figure 3).

In the sections that follow, we highlight the specific details of how we will implement our plan in 2005–2007. We present a brief overview of the issues in each priority area, identify funded projects, and then articulate the objectives, strategies, expected outcomes, performance benchmarks, and evaluations we expect to achieve.

Figure 1. *Time frame for Delaware Sea Grant's current strategic plan and the process leading to the program's next plan.*

Sea Grant Advisory Council

- Two formal meetings/year; informal contact throughout year
- Involvement in Statewide Stakeholder Strategic Planning Meeting (Oct. 2003)
- Involvement in Outreach Strategic Planning Meeting (Nov. 2004)

Delaware State Legislature

- Meetings with Governor
- Annual Report to Governor and General Assembly
- Legislative Reception

Public Input

- Statewide Stakeholder Strategic Planning Meeting (Oct. 2003)
- Annual Report/Newspaper Insert with Survey
- Ongoing Workshop/Seminar Input and Program Evaluations
- On-Line Survey on Web Site
- Visitor Survey at Coast Day
- Phone/E-mail contact

National/Regional Priorities

- NOAA Strategic Plan
- NOSG Strategic Plan
- U.S. Commission on Ocean Policy Report
- Pew Ocean Commission Report
- Delaware Estuary Program CCMP
- National/Regional Symposia

Figure 2. *Overview of the many stakeholders and factors considered in the development of Delaware Sea Grant's current five-year strategic plan.*

Sea Grant Matrix/Theme Team Areas

January 2005

NOAA Sea Grant Priority Areas	Aquaculture	Biotechnology	Coastal Communities	Coastal Hazards	Digital Ocean	Ecosystems and Habitats	Fisheries	Marine Science Literacy	Seafood Science and Technology	Urban Coasts	Invasive Species
Delaware Sea Grant Priority Areas											
Ecosystems	X	X	X	X	X	X	X	X		X	X
Environmental Technologies and Engineering			X	X	X	X		X		X	X
Biotechnology	X	X				X	X	X	X		X
Marine Commerce and Transportation	X		X	X	X	X		X	X	X	X
Marine Education, Literacy, and Outreach	X	X	X	X	X	X	X	X	X	X	X

NOAA Cross-Cutting Priority

Figure 3. *Delaware Sea Grant's Priority Areas cross-cut many of NOAA Sea Grant's current matrix/theme team areas.*

Ecosystems

Fifty percent of the world's population lives within 100 km of a coast. All three of Delaware's counties are considered coastal and are experiencing substantial population growth. The greatest growth is occurring in Delaware's southernmost county, which is bordered by both a bay and the ocean. Population increases along the Atlantic coastline have grown nearly 60% between 1990 and 2000. Overall, the resident population of Delaware is expected to grow by 31% by 2030, with the heaviest growth, 64%, occurring in Sussex County (Delaware Population Consortium 2003). Delaware Sea Grant seeks to expand the scientific and policy basis critical to sound ecosystem-based management in the wise use, protection, and restoration of coastal waters, estuaries, and watersheds and their living marine resources.

The state has embraced the concept of environmental sustainability as a goal for natural resource management agencies (see Better Models for Development: Ideas for Creating More Livable and Prosperous Communities 2004). In practice, however, management agencies have found implementation of this mandate difficult. Several obstacles stand in the way of ecosystem-based management, including (1) inadequate information on the biodiversity of the environments; (2) lack of understanding of the function and dynamics of ecosystems; (3) the openness and interconnectedness of ecosystems on scales that transcend management boundaries; and (4) the belief by some that immediate societal need and economic value of supposedly renewable resources outweighs the risk of future ecosystem damage.

Sea Grant has had a long commitment through both research and outreach to foster a better understanding of the complexities of managing dynamic ecosystems. For example, work by Delaware Sea Grant investigators has contributed to a better understanding of the dynamics of estuarine ecosystems where variations in space and time create thriving "patches" that are critical to ecosystem structure and function. Insights into these patch dynamics are a focus of the work funded under this priority for 2005–2007. In addition, scientists and outreach specialists are working in partnership with the Center for the Inland Bays to help answer questions about the relationships between water quality and the impacts of increased development around Delaware's coastal bays.

Below is the list of Ecosystems Projects we are funding in 2005–2007. Please see the table that follows for an overview of how we will implement this priority.

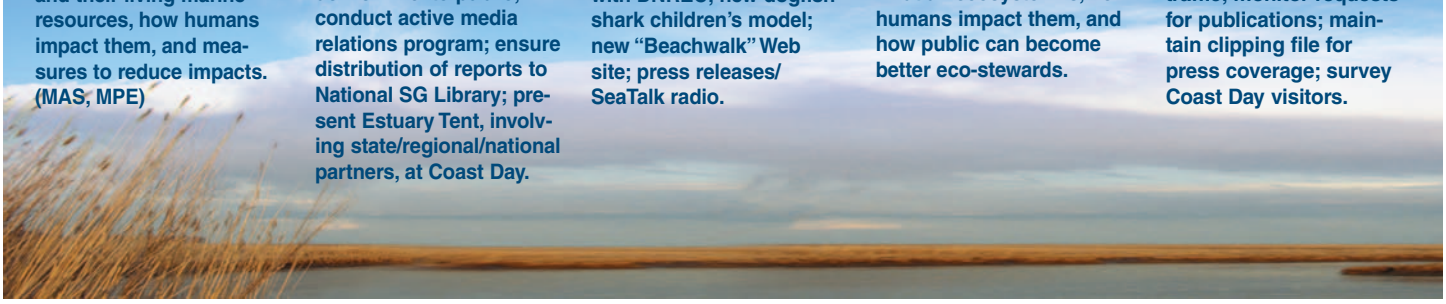
Ecosystems Projects 2005–2007

R/ECO-1	Dr. Charles Epifanio Dr. Richard Garvine	How Do Changes in Physical Conditions and Megalopae Behavior Affect Blue Crab Recruitment Variability in Chesapeake and Delaware Bays?
R/ECO-2	Dr. John Gallagher Dr. Denise Seliskar	Improving Water Quality and Maintaining Salt-Marsh Surface Elevation by Exploiting Intraspecific Variation in the Ability of Marsh Plants to Sequester Nutrients and Carbon
R/F-10	Dr. Charles Epifanio Dr. Richard Garvine	Supply of Larvae to Estuarine Nursery Habitat: Development of a Predictive Model for Blue Crabs
A/I-1	Jim Falk	Marine Advisory Service (MAS)
A/I-5	Tracey Bryant	Marine Public Education (MPE)

Sea Grant Ecosystems 2005–2007

Goal: Expand the science and policy basis critical to sound ecosystem-based management in the wise use, protection, and restoration of coastal waters, estuaries, and watersheds and their living marine resources.

Objectives	Strategies	Expected Outcomes	Performance Benchmarks	Evaluation
Understand how ecosystem processes, such as freshwater flow, affect the stock size of the Mid-Atlantic's most economically valuable fishery: the blue crab. (R/ECO-1, Epifanio/Garvine)	Identify mechanisms influencing the transport of crab young into the Chesapeake/Delaware bays; incorporate into numerical models.	Data/models useful to resource managers; students educated; journal articles; presentations at scientific meetings/Coast Day; strengthened ties among SG scientists on regional level (DE, MD)	Increased connections between researchers and resource managers to foster management-based research and ecosystem-based management.	Application to fisheries management; increased capability of model to predict effects of natural changes on ecosystem.
Identify marsh plants that have superior capabilities to store nutrients and carbon and can contribute to solution of two problems: eutrophication and sea-level rise. (R/ECO-2, Gallagher/Seliskar)	Measure nutrients/carbon in four marsh plant species in Delaware's Little Assawoman Bay Wildlife Area on seasonal basis; assess genotypic differences.	Characterization of nutrient/carbon sequestration in four marsh plant species; expanded industry partnership — Estuary Enhancement Prgm. at PSEG, Salem, NJ; students educated; journal articles; presentations at scientific meetings/Coast Day; Web site.	Increased awareness by resource managers, industry partners, and public of potential role of marsh plants in enhancing estuarine ecosystem.	Identification of marsh-plant genotypes of optimal use in improving water quality and "keeping up" with increasing sea-level rise.
Understand interrelationships between ecosystem processes, such as circulation on continental shelf and coincident variation in larval blue crab recruitment to estuarine nurseries. (R/F-10, Epifanio/Garvine)	Couple marine biology and physical oceanography to develop mathematical model that can determine the supply of larval blue crabs to Delaware Bay in any given year.	Mathematical model that will help predict fishable stock of blue crabs; students educated; journal articles; presentations at scientific meetings/ Coast Day.	Increased interest by scientists in projects that foster a multidisciplinary approach to ecosystem research.	Development of new model to help predict fishable stock of blue crabs; application of model in fisheries management.
Provide opportunities for citizens to become involved in activities in support of coastal ecosystem management (MAS, MPE)	Develop NEMO workshops, publications, and Web site; initiate new citizen monitoring program for Broadkill River watershed; evaluate potential for establishing oyster spawning sanctuaries in Little Assawoman Bay.	Comprehensive watershed outreach program for system on verge of explosive growth (Broadkill); increased community support for shellfish restoration efforts with important ecosystem benefits (water filtration, nutrient cycling).	Enhanced public understanding of relationship between human impacts and factors such as water quality and human health.	Determine if resource managers are using SG resources to improve decision-making; poll citizens in Broadkill watershed to assess understanding of water-quality impacts; evaluate potential of shellfish to improve water quality.
Increase public understanding of ecosystems and their living marine resources, how humans impact them, and measures to reduce impacts. (MAS, MPE)	Develop print, broadcast, and Web-based media to deliver info. to public; conduct active media relations program; ensure distribution of reports to National SG Library; present Estuary Tent, involving state/regional/national partners, at Coast Day.	New publication on *Phragmites* in partnership with DNREC; new dogfish shark children's model; new "Beachwalk" Web site; press releases/ SeaTalk radio.	Increased public awareness/understanding of what an ecosystem is, how humans impact them, and how public can become better eco-stewards.	Include survey on Web site and monitor visitor traffic; monitor requests for publications; maintain clipping file for press coverage; survey Coast Day visitors.



Environmental Technologies and Engineering

America's coastal waters are of vital national importance. There is a need to improve observations and modeling of critical phenomena that impact operations, activities, and human health and safety in coastal environments. Delaware Sea Grant seeks to facilitate the development of interactive observatories, sensors, autonomous samplers, and models for real-time continuous, cost-effective monitoring, forecasting, and assessment of coastal waters.

Since the early 1970s, Delaware Sea Grant has supported coastal engineering research, which largely has been directed at understanding wave dynamics and coastal processes with the goal of predicting and mitigating coastal erosion. Presently, technologies have progressed to allow researchers to think beyond the nearshore for real-time dynamic sampling. Two fundamental capabilities are required to make rational, scientifically sound decisions about a host of activities that impact the coastal ocean, bays, estuaries, watershed, and coastal shorelines: (1) an ability to monitor, on a comprehensive and cosmopolitan basis, the present state of the coastal ocean, ecosystems, and shoreline, and (2) an ability to make robust predictions about the future states of these systems.

Neither of these capabilities presently exists. However, there has been a convergence of understanding about the importance of developing and maintaining an integrated and sustained ocean observing system (IOOS) in both the international and national arenas over the past decade.

The challenge today is to build upon and incorporate technological innovations from such fields as molecular biology and biotechnology, nanotechnology, acoustics, marine geology and geophysics, remote sensing, and computational simulation and modeling into the development of long-term monitoring, adaptive sampling, and dynamical forecast systems. Such systems will enhance the understanding of processes occurring in the coastal ocean, bays, estuaries, and adjacent watersheds and shorelines, which are dynamic, difficult to sample using traditional expeditionary investigations, and are subject to increasing pressures from human activity.

Merging state-of-the-art technical capabilities for in situ observations, data communications, and numerical models will improve the accuracy and timeliness of short- and long-term predictions of potentially dangerous phenomena in our coastal waters and ports. The ability to mitigate hazards relies on the ability to predict the physical, chemical, and biological processes that determine the hazard's spatial dispersal. Integration of spatial dispersed observations with numerical models will facilitate planning for extreme events, improve safety and efficiency of maritime operations and search and rescue, increase security from water-borne threats, and enhance readiness to respond to unexpected introductions

The University of Delaware is taking a leadership role, in partnership with Sea Grant, to facilitate the development of an ocean and coastal observing system for the Mid-Atlantic region. Numerous workshops and meetings have been held with stakeholder groups and management agencies to formulate a plan for how the program will operate.

Below is the list of Environmental Technologies and Engineering Projects we are funding in 2005–2007. Please see the table that follows for an overview of how we will implement this priority.

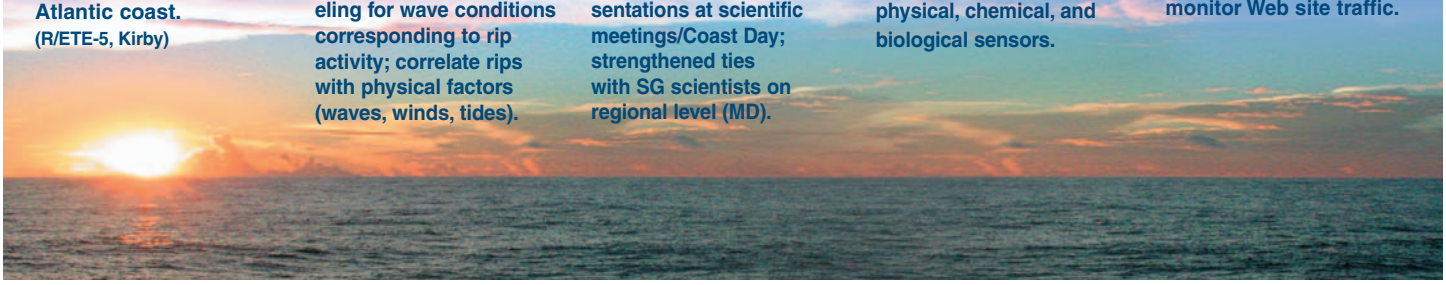
Environmental Tech. and Engineering Projects 2005–2007

R/ETE-1	Dr. K.-C. Wong Dr. M. Badiey	Prediction of Wind-Induced Subtidal Sea Level and Current Variations in the DE Estuary Based on a Combined Database from Three Coastal/Estuarine Observing Systems (PORTS, DBOS, and DEOS)
R/ETE-2	Dr. James Corbett Dr. Jeremy Firestone	Application of Decision Support Model to Reduce the Risk of Introduction of Aquatic Organisms by Maritime Commerce: Chesapeake Bay and Miami Regions
R/ETE-3	Dr. James Kirby Dr. M. Badiey, Dr. K.-C. Wong	Real-time Surface Wave Measurement and Modeling in Delaware Bay
R/ETE-4	Dr. Nobuhisa Kobayashi	Morphological Modeling of Intertidal Mudflats
R/ETE-5	Dr. James Kirby	Field Observations and Predictions of Rip Currents
R/ET-4	Dr. Xiao-Hai Yan Dr. Vic Klemas	Advancing Remote Sensing Techniques for Observing the Coastal Ocean
R/B-33	Dr. George Luther	Voltammetric Microelectrodes for the Determination of Biogeochemically Relevant Species in Sediments and Waters
R/ME-35	Dr. Christopher Sommerfield Dr. K.-C. Wong	Sediment Transport in the Delaware Estuary on Tidal Seasonal Timescales
A/I-1	Jim Falk	Marine Advisory Service (MAS)
A/I-5	Tracey Bryant	Marine Public Education (MPE)

Sea Grant Environmental Technologies and Engineering 2005–2007

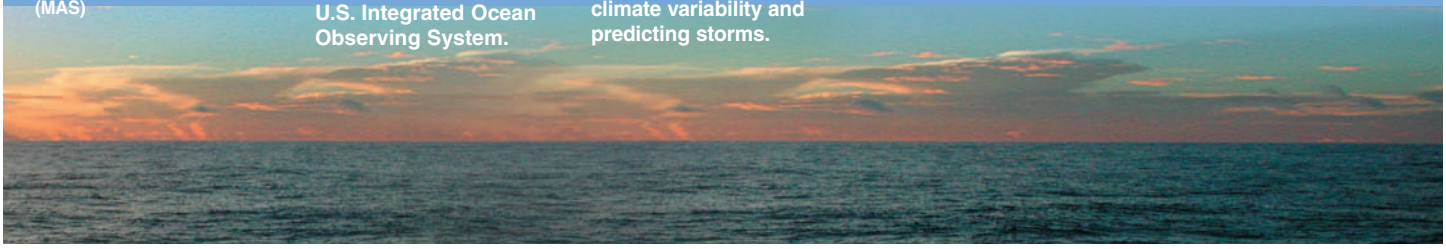
Goal: Develop interactive observatories, sensors, autonomous samplers, and models for real-time, continuous, cost-effective monitoring, forecasting, and assessment.

Objectives	Strategies	Expected Outcomes	Performance Benchmarks	Evaluation
Develop a cost-effective, accurate method of predicting the wind-induced sea level and current in Delaware Bay to aid navigation and storm management. (R//ETE-1, Wong/Badiey)	Use extensive data from three coastal observing systems: Physical Oceanography Real-Time System (PORTS), Del. Bay Observing System (DBOS), and Delaware Environmental Observing System (DEOS).	Data useful to coastal managers concerned about flooding under strong wind events and to mariners for navigation; improved predictions to aid oil spill response; Web page; presentations.	Increased partnerships with national agencies such as NOAA NOS and local agencies such as DEMA and DNREC.	Application of method/data by resource managers and the public; monitoring of Web site.
Develop methodologies and techniques for reducing the risks and costs of aquatic invasive species introductions via ballast water. (R/ETE-2, Corbett/Firestone)	Combine engineering, biology, policy, law, and economics to develop decision model to explore costs and benefits of new technologies for ballast water treatment to reduce biological pollutants.	New decision tool for use by ship/port operators and government officials, with application worldwide; incorporation into graduate case study course; journal articles; presentations to National Trans. Research Bd., etc.	Increased interest in decision tools by industry seeking to meet International Maritime Organization's Ballast Water Convention; increased interest in interdisciplinary approaches in marine research.	Use of decision models by ship/port operators; government officials; and policy/engineering scientists.
Enhance the Delaware Bay Observing System (DBOS) through addition of continuously operating, tested model for surface wave data in bay. (R/ETE-3, Kirby/Badiey/Wong)	Use combination of experimental and numerical approaches to refine the Simulating Waves Nearshore (SWAN) model built in previous DE SG research; provide data access via DBOS Web site.	First model for assessing spatial/temporal variability of wave activity in Delaware Bay, aiding evaluation of shoreline erosion potential, navigation hazards, etc.; students educated; journal articles; presentations; partnerships with NOS, DEMA, DNREC.	Increased monitoring of the coastal ocean with physical, chemical, and biological sensors and tested data models; data for refining models for water transport, shoreline erosion.	Use of data by resource managers, public. Monitor Web site traffic.
Develop a morphological model for intertidal mudflats that will increase understanding of these gently sloping areas, sensitive to sea-level rise. (R/ETE-4, Kobayashi)	Develop a model for predicting the morphological changes of intertidal mud flats due to sea-level rise, tides, and wind waves; validate model using field data provided from previous experiments.	New model useful to coastal engineers/scientists for predicting effects of sea-level rise on intertidal mudflats; enhanced partnership with PI at Kumamoto Univ., with support from Japan's Ministry of Ed., Science and Culture.	Increased understanding of morphology of intertidal mud flats; increased monitoring of coastal ocean with physical, chemical, and biological sensors.	Use of model by coastal engineers and scientists on local to international levels.
Develop a camera-based beach observing system for forecasting rip current activity along DE's and MD's Atlantic coast. (R/ETE-5, Kirby)	Install cameras at Bethany Beach, DE, and Ocean City, MD, and establish Web site; conduct numerical modeling for wave conditions corresponding to rip activity; correlate rips with physical factors (waves, winds, tides).	Permanent coastal observation system on DE and MD coast that can predict rip currents; students educated; journal articles; presentations at scientific meetings/Coast Day; strengthened ties with SG scientists on regional level (MD).	Installation of camera system at DE beach and then at MD beach; increased monitoring of coastal ocean with physical, chemical, and biological sensors.	Use of data by various audiences, including National Weather Service, lifeguards, beach communities, public at large; monitor Web site traffic.



Environmental Technologies and Engineering (Cont'd.)

Objectives	Strategies	Expected Outcomes	Performance Benchmarks	Evaluation
Develop new techniques for incorporating satellite data into a coastal ocean observing system. (R/ET-4, Yan/Klemas)	Use data from NASA and NOAA radiometers, high-resolution Synthetic Aperture Radar, and other sources to develop new data processing and feature tracking techniques, and methods of incorporation into DBOS.	New satellite-based techniques useful in monitoring phenomena ranging from chlorophyll to sea ice in Delaware Bay; students educated; journal articles; presentations; partnerships with NOAA NESDIS, Naval Research Lab, DNREC, DBRC.	Increased use of satellite data in assessing ecosystem health; increased knowledge of relationship between physical and biological marine processes.	Use of data and techniques by the scientific and resource management communities.
Deploy chemical sensor to provide continuous, real-time water-quality measurements as part of Delaware Bay Observing System (DBOS), and in DE's Inland Bays. (R/B-33, Luther)	Integrate a solid-state gold-amalgam microelectrode developed in previous DE SG research into DBOS; deploy second sensor in Inland Bays to document seasonal anoxia in deep holes.	Data useful to resource managers; increased understanding of redox processes and ecosystem health; students educated; journal articles; presentations; sharing of tool with scientists internationally.	Increased use of sensor data; increased capability to predict effects of water-quality changes on coastal ecosystem health.	Use by coastal managers/scientists in monitoring water quality of Del. Bay and in developing restoration strategies for DE's Inland Bays; also potential application to other shallow systems in U.S.
Elucidate the mechanisms that moderate the concentration and transport of suspended sediments in the Delaware Estuary (R/ME-35, Sommerfield/Wong)	Use bottom-mounted and moored sensors to measure currents, suspended sediments, salinity, and temperature for three months in fall (low discharge) and spring (high discharge); expand on previous DE SG research.	Data essential to environmental agencies/engineers in developing numerical models of material transport; enhanced regional partnership with DRBC; students educated; journal articles; presentations.	Increased use of data by DRBC and other resource managers.	Use of data by resource managers on a regional level for the development and fine-tuning of predictive models.
Deploy existing and/or developing technologies for use in determining both short-term environmental events and long-term environmental trends. (MAS)	MAS will work with cooperating agencies to coordinate needs, specifications, and end-users for deployment of nearshore directional wave gauge.	Real-time data on wave parameters (height, peak period, direction) and water surface elevation useful to coastal managers, NWS, emergency management, public.	Increased awareness of wave data availability and its applications by coastal managers and by public.	Use of data by target audiences, including NWS, emergency management agencies, beach communities, and public at large; monitor Web site traffic.
Increase public awareness/understanding of what an ocean observing system is and how it can benefit humans and the ecosystem. (MAS, MPE)	MAS/MPE will assist SG researchers in promoting/enhancing the DBOS Web site through public/teacher workshops highlighting data applications, Web pages on wave/ocean dynamics and rip currents; "Coastal Currents" fact sheets; press releases.	Expanded info. for DBOS Web site; new Web pages on wave/ocean dynamics and rip currents; fact sheets; press releases.	Increasing interest in/awareness of DBOS as evidenced by news stories, Web traffic, etc.	Use of Web/print information by public and targeted user groups. Incorporate survey into Web site; monitor Web site traffic, requests for publications, news coverage.
Transfer information and technology to coastal constituents on predicted risks, expected impacts, and effective prevention and recovery strategies. (MAS)	MAS will assist in coordinating new Mid-Atlantic Coastal Ocean Observation Regional Association (MACOORA), a major node in the U.S. Integrated Ocean Observing System.	Coordinated system integrating data from DBOS et al. to provide wide range of public benefits, from advancing national security to monitoring climate variability and predicting storms.	Increased monitoring of the coastal ocean with physical, chemical, and biological sensors; increased interest in data by target audiences.	Determine whether MACOORA is meeting the needs of all target audiences that have been identified.



Biotechnology

Biotechnology is the application of scientific and engineering principles and their associated tools to the processing of materials from biological agents to provide goods and services. Marine biotechnology has its roots in the specific adaptations of marine organisms to their environment. Delaware Sea Grant seeks to catalyze the exploration, development and use of marine biotechnologies to improve and protect the coastal ocean and human health and develop novel industrial processes and products based on the specific adaptations found in marine organisms.

The world's oceans are biologically diverse, with two-thirds of the 36 known phyla exclusively or predominantly found in the marine environment. Much of the diversity is just beginning to be appreciated, especially for the marine microbial community, many of which are not culturable by conventional methods. On a macro-organism scale, the oceans remain the largest source of wild or domestic protein in the world, with global fish production exceeding that of cattle, sheep, poultry or eggs.

As more and more organisms are discovered in environments with extreme temperatures, salinity, pollution, anoxia, and other kinds of stresses, we learn more about the molecular and physiological basis of adaptation. This in turn forms the basis of potential indicators to monitor changes in environmental quality and for potential novel new products and processes of economic benefit. The information and technology now available to all scientists as a result of genomics research not only provides new perspectives on the inner workings of biological systems, but also provides new opportunities to use this knowledge to address major environmental challenges. Biotechnology can contribute a new array of powerful tools for assessing ecosystem health and increasing our understanding of the processes involved in ecosystem maintenance.

The Delaware Sea Grant College Program has been involved in the study of marine natural products since the mid-1970s. Some of the early natural products research focused on chitin and its medical applications; more recently, Delaware Sea Grant investigators have used marine biotechnology in the study of disease resistance in shellfish, biomaterials from marine organisms living in extreme environments, and molecular detection of exotic species and the development of artificial, horseshoe crab-like bait for the eel and conch fisheries. Within this important area, Delaware Sea Grant has given funding priority for 2005–2007 to projects that are complementary and supportive of other Delaware Sea Grant program priority areas and possess the potential for added investment from other funding sources. In supporting this, Delaware Sea Grant is building on partnerships with the Delaware Biotechnology Institute and working in a state climate in which there is a strong commitment to expand biotechnology.

Below is the list of Biotechnology Projects we are funding in 2005–2007. Please see the table that follows for an overview of how we will implement this priority.

Biotechnology Projects 2005–2007

R/F-22	Dr. Patrick Gaffney	Molecular Genetic Tools for Monitoring Stock Enhancement Efforts: Application to Chesapeake Bay Oysters
R/F-9	Dr. Pamela Green Dr. Yu-Sung Wu	Bioengineering a Better Bait: The Search for Practical Alternatives to the Horseshoe Crab
A/I-1	Jim Falk	Marine Advisory Service (MAS)
A/I-5	Tracey Bryant	Marine Public Education (MPE)

Sea Grant Biotechnology 2005–2007

Goal: Catalyze the exploration, development, and use of marine biotechnologies to improve and protect the coastal ocean and human health and develop novel industrial processes and products based on the specific adaptations found in marine organisms.

Objectives	Strategies	Expected Outcomes	Performance Benchmarks	Evaluation
Develop genetic methods for monitoring the survival and reproduction of outplanted oyster stocks in Chesapeake Bay as part of regional efforts to enhance a once-vital fishery important to the economy and heritage of the Mid-Atlantic region. (R/F-22, Gaffney)	Refine mitochondrial DNA sequencing techniques identified in previous DE SG research to detect outplanted oysters and their progeny.	New molecular methods that can reliably identify mtDNA haplotypes in hatchery lines and provide for rapid, efficient scoring of large numbers of wild-caught oysters in order to track success of outplanted seed; students educated; journal articles; presentations at scientific meetings/Coast Day; strengthened ties among SG scientists on regional level (DE, MD)	Increased genomic/proteomic data on Chesapeake Bay oysters; testing of larval stocking as an alternative means of oyster population enhancement.	Application of DE SG molecular marking techniques to assess larval- and spat-based stock enhancement efforts; nationally, interest in/application of protocols/techniques to other shellfish and finfish restoration programs; potential application of screening methods to monitor for aquatic species invasions.
Develop a cost-effective artificial bait for eels and conch based on the natural attractant found in the horseshoe crab — a declining Mid-Atlantic resource — but produced independently of the horseshoe crab. (R/F-9, Green/Wu)	Use molecular techniques to isolate and characterize attractant in female horseshoe crab; synthesize and incorporate attractant into cost-effective bait; with MAS assistance, identify commercial outlet to produce quantities of bait for field tests involving fishermen.	Artificial bait that will relieve fishing pressure on horseshoe crab by providing fishermen with effective alternative; students educated; journal articles; presentations at scientific meetings/Coast Day; strengthened ties with funding partners (SG, DNREC, NFWF, DuPont)	Success of bait product in field trials; "buy in" by fishermen and by resource managers.	Development of a bait product that fishermen will use, thus aiding resource managers charged with protecting the spawning stock of horseshoe crabs, as well as fisheries associated with the horseshoe crab industry (eel, conch).
Extend research results to industry, media, and specific audiences and strengthen academic, industry, and government partnerships for public benefit. (MAS, MPE)	Use print, broadcast, and Web-based media to deliver info. to public; ensure distribution of DE SG reports to National SG Library; present info. at Coast Day and other public events; coordinate annual census of spawning horseshoe crabs on Delaware beaches to aid resource management and involve public.	Updated horseshoe crab outreach materials incorporating latest SG research and outreach results — standards based MAS Bulletin, Horseshoe Crab Model, public exhibit, and regional Web site; press releases.	Increased awareness/understanding of importance of horseshoe crabs and SG research by resource managers, government officials, schoolchildren, and public; response/involvement of watermen in field testing artificial horseshoe crab bait.	Evaluate survey results from regional horseshoe crab Web site and monitor visitor traffic; monitor requests for publications and teacher usage of curricular materials; maintain clipping file for press coverage.

Marine Commerce and Transportation

The present and future economic well-being of the State of Delaware and the Mid-Atlantic region are inextricably linked to coastal and marine resources. Delaware Sea Grant seeks to increase the economic competitiveness and sustainability of businesses and industries dependent on the ocean and the coast. Coastal communities face critical management challenges — especially how to balance development with the maintenance and enhancement of coastal environmental quality.

Delaware's coasts, as with coastal areas throughout the world, are facing strong population growth, declining natural environments, and overburdened coastal and marine resources. These factors create the compelling need to foster coastal business growth and community development strategies that are compatible and sustainable. There are many businesses dependent on marine and coastal resources that are small; e.g., those engaged in tourism and marine trades. They often operate at risk. At-risk businesses need to increase productivity and efficiency by adopting new technologies, while at the same time adapting to changes in the regulatory environment and maintaining access to the marine environment.

At the other end of the economic spectrum, but at no less risk, are maritime commerce and marine transportation. The Port of Wilmington in Delaware is but one example of the many major port facilities in the Mid-Atlantic facing numerous economic, environmental, and security challenges and technological changes. Marine transportation is generally recognized as one of the most economically significant and important uses of the world's oceans. World trade moves largely through ships. Marine transportation accounts for about 71% of the 60 trillion tonne-km of world trade. The U.S. marine transportation system ships over 95% of the tonnage of our foreign trade through American ports. Despite its economic importance, marine transportation often does not receive concerted high-level policy attention. There are numerous issues facing the marine transportation industry; they include safety in shipping, maritime security in ports and harbors, and environmental issues such as ballast water discharges, invasive species, and air pollution from ships.

In the past, Delaware Sea Grant has tapped the marine policy expertise at the University of Delaware to address natural resource valuation, governance, and marine transportation issues. In addition, the Marine Advisory Service has been particularly focused on assisting the recreation and tourism industry dependent on the ocean and coast. In 2001, Delaware Sea Grant added a part-time Agent/Specialist to deal with ports, harbors, and marine transportation issues, especially those of relevance to the Delmarva region. These activities have always been carried out as contributions to addressing other Sea Grant priorities. However, recognizing the emerging importance of this area, our current five-year Strategic Plan identifies marine commerce and transportation as a free-standing high-priority area. Competing economic and environmental sustainability concerns have elevated the need for solutions.

Below is the list of Marine Commerce and Transportation Projects we are funding in 2005–2007. Please see the table that follows for an overview of how we will implement this priority.

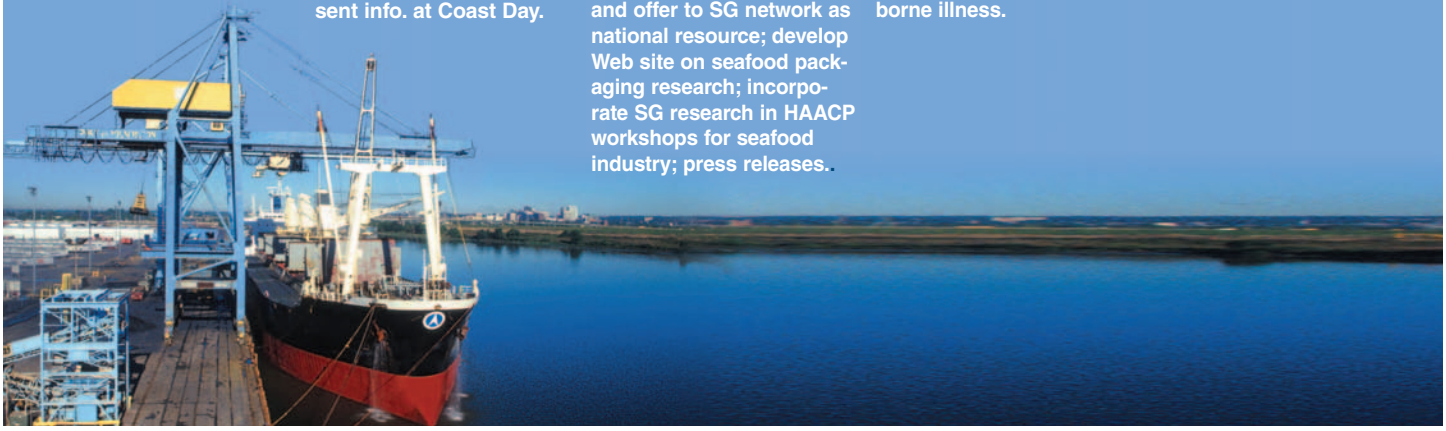
Marine Commerce and Transportation Projects 2005–2007

R/CT-1	Dr. Haiqiang Chen Dr. Dallas Hoover	Use of Antimicrobial Packaging Films to Control *Listeria monocytogenes* in Fish and Fish Products
R/CT-3	Dr. George Parsons	An Economic Analysis of Beach Use in the Mid-Atlantic Region
A/I-1	Jim Falk	Marine Advisory Service (MAS)
A/I-5	Tracey Bryant	Marine Public Education (MPE)

Sea Grant Marine Commerce and Transportation 2005–2007

Goal: Increase the economic competitiveness and sustainability of businesses and industries dependent on the ocean and coast.

Objectives	Strategies	Expected Outcomes	Performance Benchmarks	Evaluation
Determine the potential of antimicrobial packaging in controlling *Listeria monocytogenes* — a major food safety problem — and in extending the shelf life of seafood. (R/CT-1, Chen/Hoover)	Use packaging films containing nisin and modified atmosphere packaging (MAP) on fresh and smoked salmon; conduct consumer panel to assess effect of packaging films on fish taste, texture, etc.	New seafood packaging method useful to industry; students educated; journal articles; presentations at scientific meetings/Coast Day; strengthened ties with national/regional associates (NY SG, MD SG, VA SG, NFPA, NFI).	Expanded data on use of packaging films containing nisin and MAP and their effects on fresh and smoked seafood; increased interest in research by seafood industry.	Application of data/technologies by seafood industry, government agencies, resulting in improved consumer safety; increased consumer awareness of seafood safety concerns and safeguards.
Examine and quantify the interconnectivity between beaches as "critical natural capital" and the tourist economy that depends on the health of these beaches. (R/CT-3, Parsons)	Design a random utility model of recreational beach use for the U.S. Mid-Atlantic population; apply the model to selected policy issues on DE's beaches including beach closure, beach narrowing, and congestion.	Model, data, and policy analyses useful to coastal managers; students educated; journal articles; presentations at scientific meetings/Coast Day; strengthened ties with partners at state (DNREC) and fed. levels (NOAA NOS).	Enhanced capability of model to predict relative impacts and economic implications of trends such as population growth; increased interest by other states/agencies in using the model.	Application of model by state/federal resource managers to predict how visitation patterns change with changes in regional demographics and in beach characteristics such as closure of a beach, and associated economic impacts.
Determine and relay information on the relationship between people and their changing environment on the state of ecosystems and waterways in Delaware and the region. (MAS)	Regional workshop, coordinated by MAS, to discuss state of marine industry in the Delaware River and Bay.	Provide forum to air contentious issues with objectivity; identify opportunities for economic growth; elevate profile of marine transportation in Delaware River and Bay; enhance ties with regional agencies (Delaware Estuary Program, DRBA, DRBC).	Increased awareness of Sea Grant's role as objective resource — "honest broker"— by marine industry, government officials, NGOs, and public.	Survey participating industries to determine if they felt dialogue was beneficial. Monitor future outcomes to determine if they contribute to stimulation of economy.
Increase public awareness/understanding of marine transportation and seafood safety issues being addressed through DE SG research, outreach, and education programs. (MAS, MPE)	Use workshops, print, broadcast, and Web-based media to deliver marine transportation and seafood safety info. to public; ensure distribution of DE reports to National SG Library; present info. at Coast Day.	Maintain DE SG's Web site on *Athos I* oil spill in Delaware River; develop seafood public service announcements for use on Web, TV, visitor centers; update "Consumer Guide to Safe Seafood Handling" and offer to SG network as national resource; develop Web site on seafood packaging research; incorporate SG research in HAACP workshops for seafood industry; press releases..	Increased public awareness/understanding of marine transportation and commerce in Delaware Valley region; increased public awareness of seafood safety issues and how to protect from foodborne illness.	Monitor Web visitor traffic and requests for publications; maintain clipping file for press coverage; survey seafood consumer guide readers to assess behavioral change.



Marine Education, Literacy, and Outreach

Delaware Sea Grant is committed to educating future environmental professionals/leaders, enhancing marine literacy across all population groups, and providing science-based technical assistance to marine resource users, constituents, and stakeholders.

Virtually every serious study of national goals for the 21st century underscores the importance of education to national prosperity. A longstanding goal of the Delaware Sea Grant Program has been to educate our nation's future environmental leaders by giving graduate students and selected undergraduates the opportunity to develop their research and analytical skills by assisting scientists with Sea Grant projects. Through support to undergraduate and graduate education, and through skill-based training, Delaware Sea Grant produces well-prepared natural scientists, social scientists, engineers, and other professionals that increase economic competitiveness of the state, region, and nation and who devise and lead creative management concepts to keep our marine and coastal environments sustainable for future generations.

In order to sustain a growing economy, people must also be stewards of the natural environment upon which all life depends. To that end, having a scientifically literate, environmentally responsible population is necessary for Delaware and the citizens of the Mid-Atlantic region to remain competitive in the national and world economy while conserving our marine and coastal resources. Educating the 21st-century workforce toward literacy in the marine and aquatic sciences is integral to both the educational and scientific programs of Delaware Sea Grant. Our education efforts will continue to contribute to improving marine and aquatic literacy by enhancing education among formal K–12, and informal public, post-secondary, and adult audiences. The challenge is to ensure an educational process that imparts knowledge to support development of values in an environmentally literate citizenry and to foster an environment wherein ocean sciences and education are recognized by the state and regional public as being integral to national security, economic development, and the overall quality of life.

Another part of this priority area is the responsibility to transfer to the marine resource users, decision makers, and the general public a wide variety of information gained through Sea Grant research. This outreach mission is shared between members of our Marine Advisory Service (MAS) and Marine Public Education (MPE) staffs. These two groups also embark on independent efforts in applied research and marine education to address user problems and needs, and to heighten public awareness and understanding of marine and coastal environments and issues.

The "information superhighway" poses a major challenge to those with the charge to inform and educate — that is, to stay current with the rapid production of knowledge and information and the ever-improving technologies that reach larger audiences. An important goal during this strategic plan period is for our program to build online communities of constituents to increase public awareness and understanding of marine and coastal issues. The expanded use of e-newsletters, Web sites, formal and informal Web-based educational programs, and other electronic tools will be critical to our success in serving the information needs of our constituents in this age of "New Media." Achieving this goal will require an increased investment in personnel, time, and technology to digitally prepare and rapidly "serve out" our message to users and engage them in an electronic learning environment. Also, customizing information to targeted user groups, ranging from industry representatives to boaters to reporters, will enable outreach staff to reach constituent groups efficiently and effectively with the latest Sea Grant information.

Below is the list of Marine Education, Literacy, and Outreach Projects we are funding in 2005–2007. Please see the table that follows for an overview of how we will implement this priority.

Marine Education, Literacy, and Outreach Projects 2005–2007

A/I-1	Jim Falk	Marine Advisory Service (MAS)
A/I-5	Tracey Bryant	Marine Public Education (MPE)

Sea Grant Marine Education, Literacy, and Outreach 2005–2007

Goal: Educate future environmental professionals/leaders, enhance marine literacy across all population groups, and provide science-based technical assistance to marine resource users, constituents, and stakeholders.

Objectives	Strategies	Expected Outcomes	Performance Benchmarks	Evaluation
Develop partnerships that support programs and training opportunities for educators involved in formal (K–12) and informal education. (MAS, MPE)	Work with researchers, COSEE, and SGEN colleagues to integrate marine research and education programs and encourage lifelong learning experiences for all, especially educators, students (K–16), coastal managers, families, and underserved audiences.	A more informed citizenry (K– gray) who will work to protect and conserve marine resources; use of coastal ocean observing systems to promote awareness and understanding of the ocean.	Increased awareness/ interest in ocean science and greater involvement in marine education programs by teachers, students, and public.	Poll teachers, informal educators, and others. Determine whether greater awareness and understanding of the oceans is occurring.
Develop partnerships that support programs and training opportunities for educators involved in formal (K-12) and informal education. (MAS, MPE)	Develop and deliver outreach programs — from teacher professional development workshops to virtual field trips — in subprogram area of K–12 Science Education, Youth Development, and Lifelong Learning	Increased support for marine education initiatives from federal, regional, and state agencies; a better-trained workforce and better-informed lifelong learners capable of making wise decisions about marine environment.	Increased infusion of marine and aquatic science concepts and research in the K–12 curriculum, museums, and mass-media outlets.	Determine whether students/public are benefiting as a result of SG outreach programs. Conduct formal assessments of K–12 teacher workshops and on-line virtual field trips.
Advance the education of future environmental professionals/leaders through post-secondary opportunities. (Program Management, Researchers, MAS, MPE)	Provide grad/undergrad students with local and national opportunities to assist in marine research through DE SG projects and NOAA SG fellowships; present annual DE SG Student Award for exemplary research; host state Marine Science Teacher of Year Award in conjunction with Governor's Office.	A highly educated, diverse workforce attuned to the sciences and issues pertinent to marine and aquatic science.	Increased interest in marine education opportunities.	Monitor number of applications/nominations; poll students about impacts of experience.
Develop new marine and coastal communications products and outreach programs using existing media and emerging technologies. (MPE)	Explore Web-based content management systems and other cost-effective electronic tools to prepare and deliver info. rapidly to news media and to public.	Ocean News Service to serve out info. rapidly to news media; expansion of *AT SEA* e-newsletter for public.	Increased use of info. by reporters; media coverage of marine/coastal issues.	Monitor subscribership and placements; maintain clipping file.

Marine Education, Literacy, and Outreach (Cont'd.)

Objectives	Strategies	Expected Outcomes	Performance Benchmarks	Evaluation
Support citizen-based education programs that allow the public to become directly involved in coastal environmental stewardship and economic issues. (MAS, MPE)	Develop oyster gardening and water-quality monitoring programs; coordinate regional horseshoe crab census; support Docents Program, introducing visitors to SG research at UD Lewes campus.	Development of coastal stewards; Informed citizenry better connected to and aware of marine environment and issues.	Growing interest in volunteer programs; recognition of their importance by state/national officials.	Number of volunteers; survey volunteers periodically to determine effectiveness of learning experience.
Create relevant communications products and outreach programs in support of watershed management and coastal ecosystems (MAS, MPE)	Develop and deliver info. via citizen-based water-quality monitoring programs, NEMO workshops, seminars, print, broadcast, and Web-based media.	Increased awareness of human impacts on watersheds and how to reduce impacts.	Growing involvement in programs by various groups: homeowners, local officials, etc.	Determine, through formal and informal surveys, if resource managers/citizens/ environment are benefiting as a result of SG outreach programs.
Create relevant communications products and outreach programs in support of coastal community preservation (MAS, MPE)	Develop and deliver outreach programs, keying on Livable Delaware and "smart growth" principles, through workshops, seminars, print, broadcast, and Web-based media.	Preservation of quality of life in coastal areas.	Increased incorporation of smart-growth principles in coastal planning by developers, community officials, and public.	Determine, through formal and informal surveys, if coastal communities are benefiting from SG outreach programs.
Create relevant communications products and outreach programs in support of fisheries and aquaculture technology (MAS, MPE)	Develop outreach efforts, from seminars to Web sites, that support state/ regional management agencies; identify and respond to issues in aquaculture industry, commercial fishing sector, and recreational anglers.	Problem-solving techniques for aquaculture industry; increased awareness of business and safety practices by fishing industry; increased public awareness of fisheries issues.	Increased interest in fisheries management issues, recreational and commercial fishing, and aquaculture industry.	Determine, through formal and informal surveys, if fisheries industries and citizens are benefiting from SG outreach programs.
Create relevant communications products and outreach programs in support of coastal processes, hazards, and disaster preparedness. (MAS, MPE)	Develop and deliver outreach efforts, from interpretive signage along boardwalks to Web sites, to boost awareness of hazards such as rip currents, lightning, northeasters, and flooding.	Increased public awareness of coastal hazards to prevent injuries and loss of life.	Increased interest by coastal communities in acquiring outreach info., through seminars to interpretive signage.	Determine, through formal and informal surveys, if citizens are more aware of risks and safety guidelines as a result of SG outreach programs.
Create relevant communications products and outreach programs in support of seafood science, technology, and consumer education. (MAS, MPE)	Develop and deliver outreach programs, from publications to Web sites, to reach industry with latest HACCP info. and to increase consumer awareness of handling techniques to keep seafood safe.	HACCP training for seafood industry; Increased public awareness of the health benefits and risks associated with eating seafood.	Increased interest by public and retailers in seafood outreach programs and products.	Assess consumer awareness of seafood safety guidelines — "behavioral change — through formal and informal surveys.